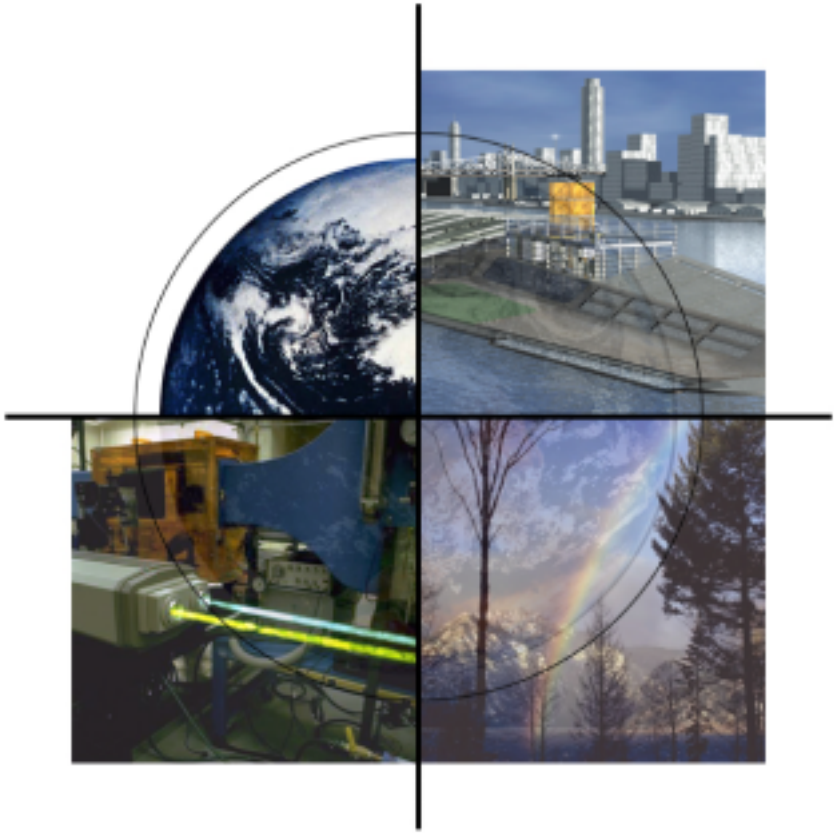
Clean Coal Power Initiative (CCPI)



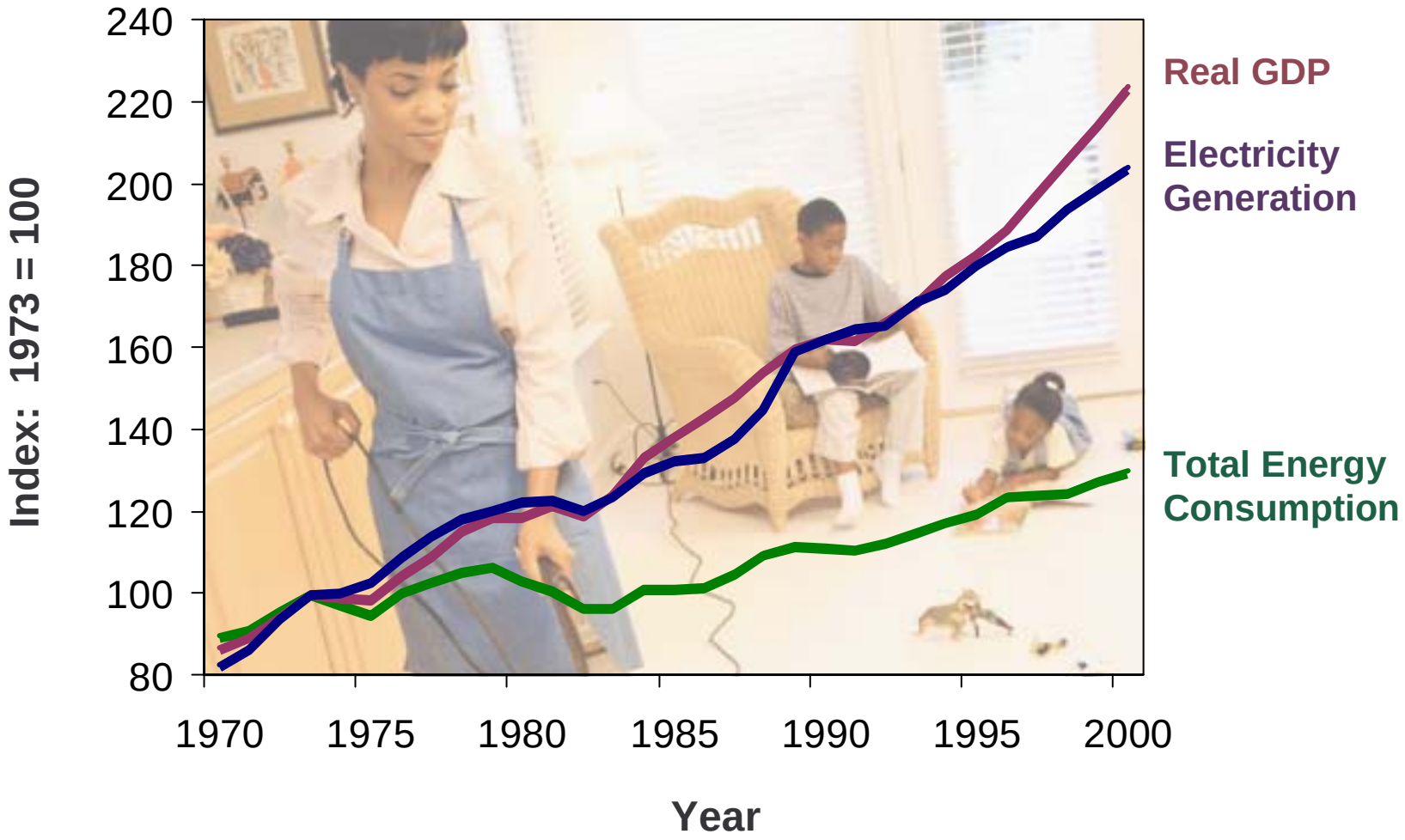
Demonstration Projects

- *Overview & Status*
- *Path Ahead*
- *Benefits*
- *Future FBC demos?*

May 21, 2003
at
17th International Conference on Fluidized Bed Combustion

National Energy Technology Laboratory - Michael Eastman

Economic Growth Linked to Electricity



GDP: U.S. DOC, Bureau of Economic Analysis
Energy & Electricity: EIA, AER Interactive Data Query System

What role for Fluid Bed Combustion Technology? —

Research priorities and prospects

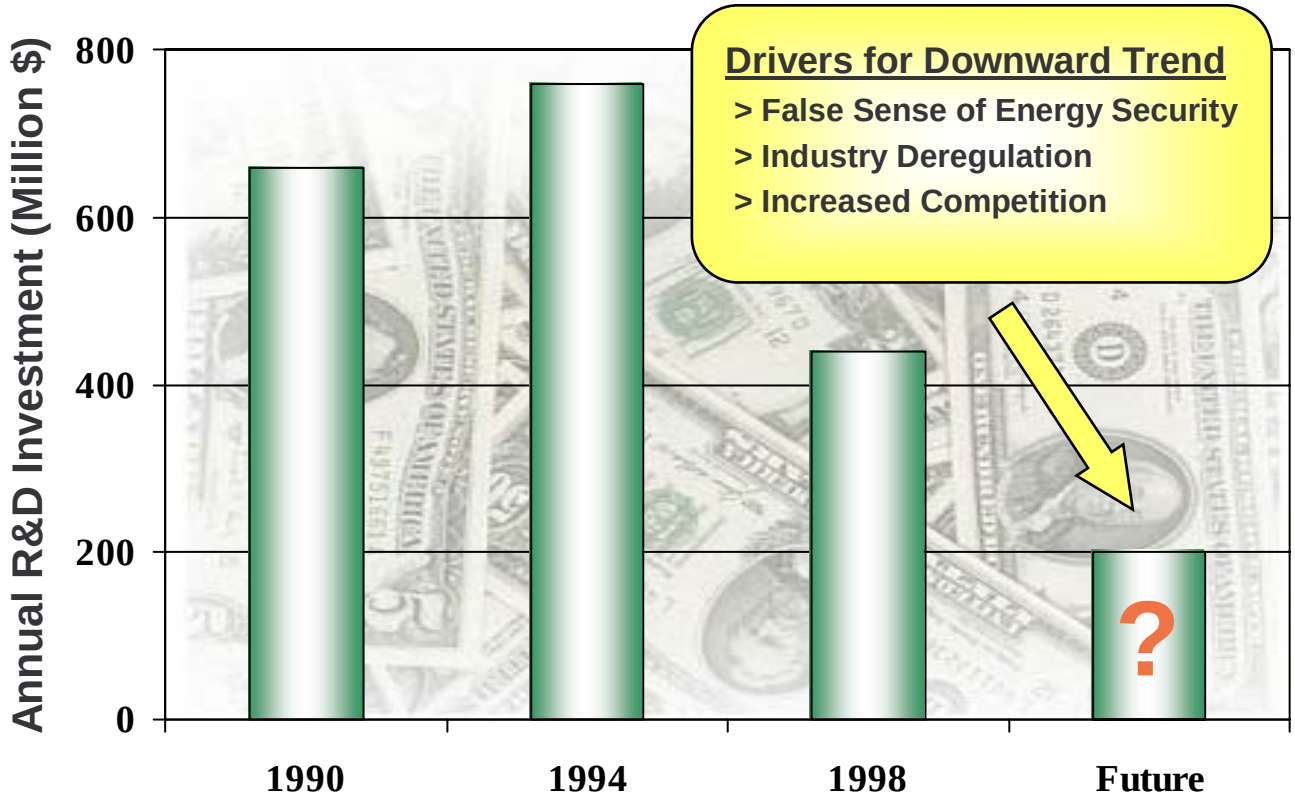
Major Energy Challenges Are on Horizon

National Security More Strongly Linked to Energy Security

Climate Change
3P Regulations
Energy/water

Potential for Future Reliability Mishaps

Downward Investment Trend by Utilities

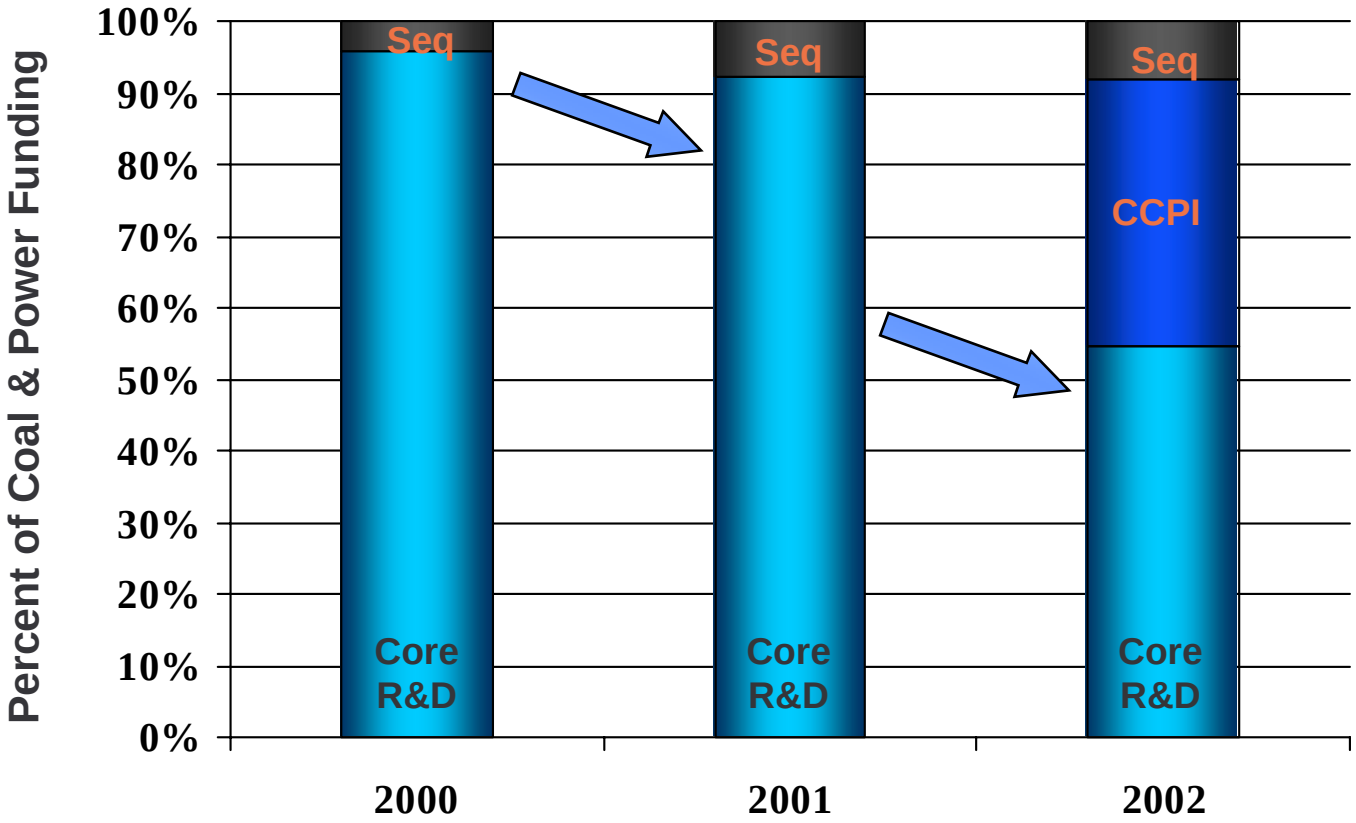


U.S. Utility Investment in R&D

Source: EPRI Roadmap

Closer Look at Recent Coal & Power Trends

(New Initiatives "CCPI & Sequestration" Squeezing Core R&D)

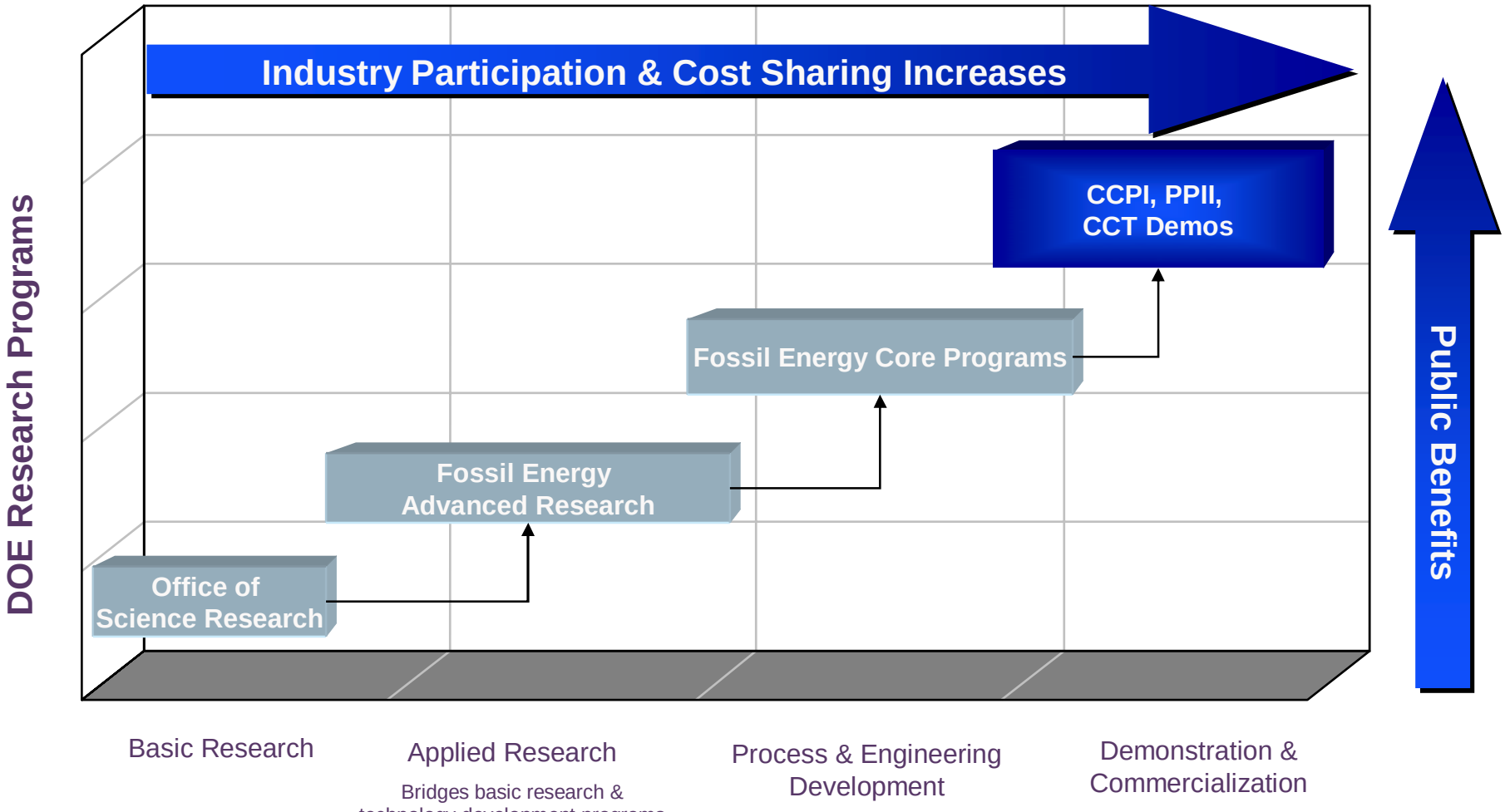


Fossil Energy & NETL R&D Funding Profiles

Source: FE/NETL Budgets

Stages of Energy RD&D

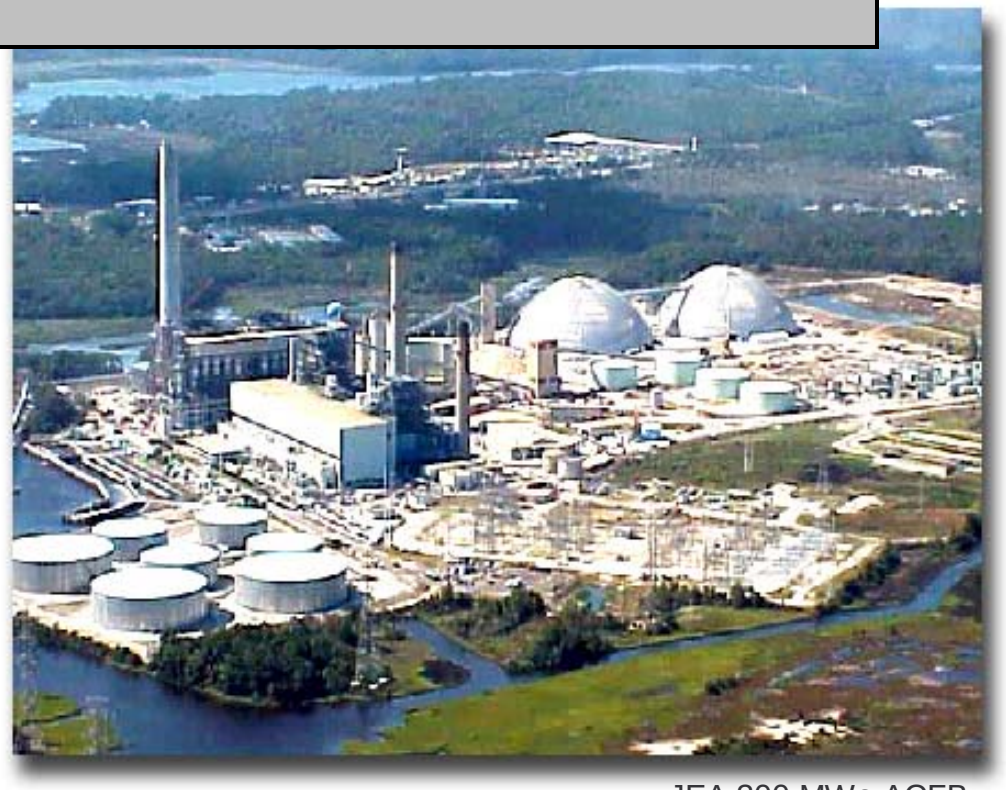
Technology demonstrations play an enabling role



Demonstration Program Funding

(in thousands)

	FY2002 Enacted	FY2003 Conference	FY2004 President
CCPI	146,065	150,000	130,000



JEA 300 MWe ACFB

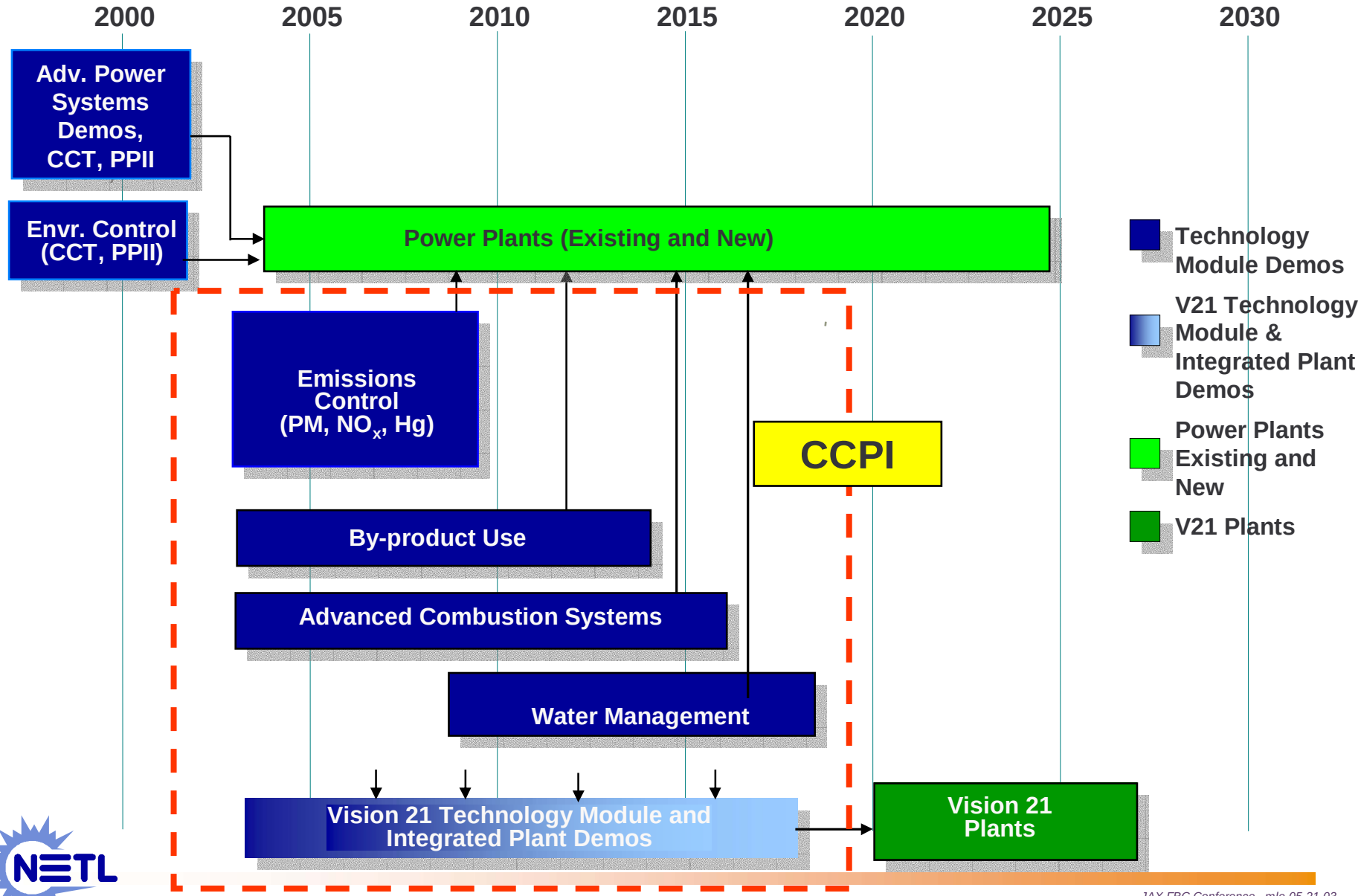
Coal RD&D Technology Roadmap —

Charts road ahead for coming demonstrations

Coal Power Program Roadmap Addresses Near- and Long-range Needs

- **Short-term: existing fleet**
  - Cost-effective environmental control technologies to comply with current and emerging regulations
- **Long-term: future energy plants**
  - Near-zero emissions power and clean fuels plants with CO_2 management capability

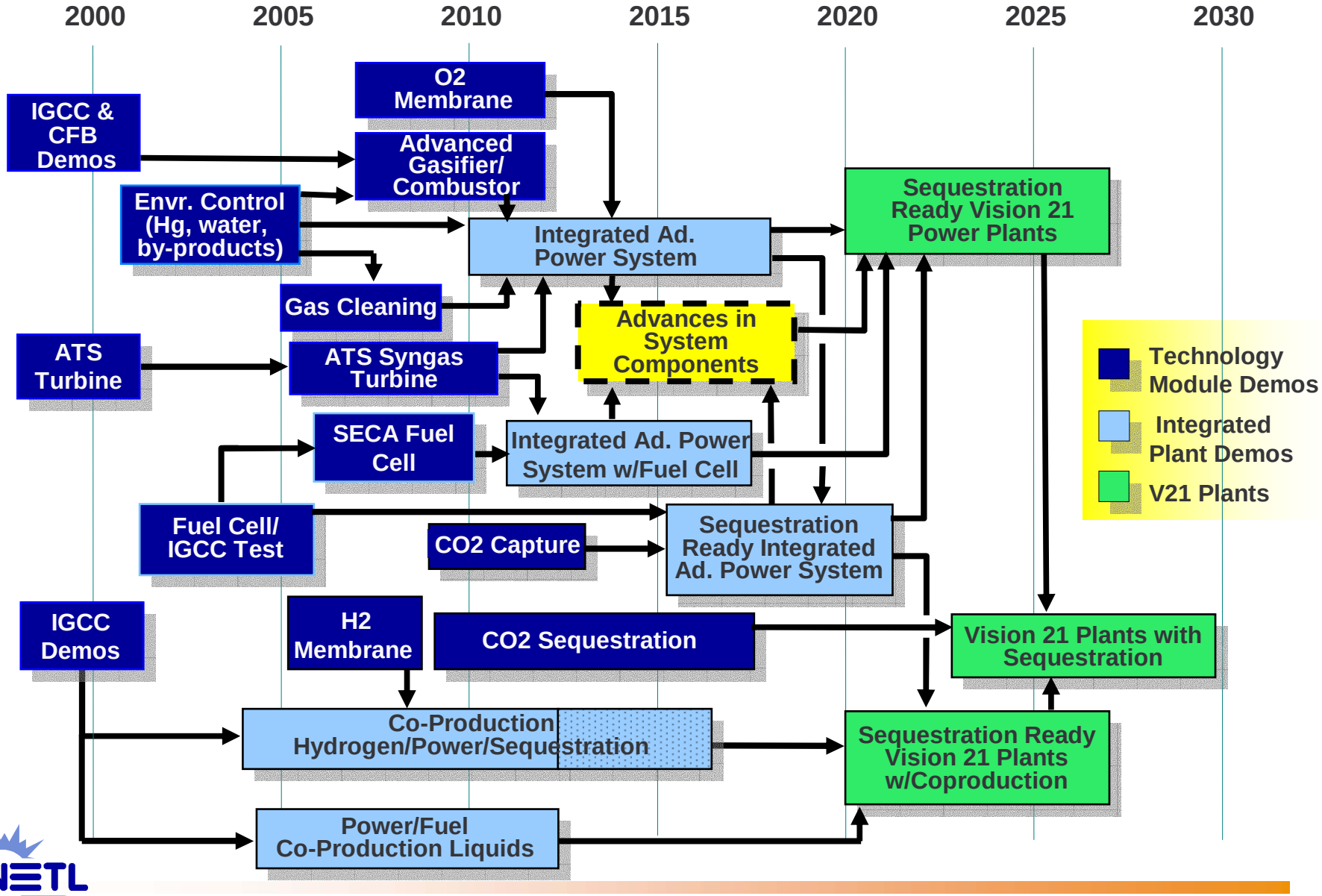
Demonstration Targets – Existing Plants



Existing Plants
Roadmap Performance Objectives

- Reduced Cost for NOx Control
- Reduced Cost for High-Efficiency Hg Control
- Achieve PM Targets in 2010: 99.99% capture of 0.1 – 10 μ Particles

Demonstration Targets to Vision 21 Plants



Coal Power Program Roadmap
New Plant Performance Targets
(Represents best integrated plant technology capability)

	Reference Plant	2010	2020 Vision 21
Air Emissions	98% SO_2 removal	99%	>99%
	0.15 lb/10^6 Btu NOx	0.05 lb/10^6 Btu	<0.01 lb/10^6 Btu
	0.01 lb/10^6 Btu Particulate Matter	0.005 lb/10^6 Btu	0.002 lb/10^6 Btu
	Mercury (Hg)	90% removal	95% removal
By-Product Utilization	30%	50%	near 100%
Plant Efficiency (HHV)	40%	45-50%	50-60%

Coal Power Program Roadmap

New Plant Performance Targets[1]

(Represents best integrated plant technology capability)

	Reference Plant	2010	2020 Vision 21
Availability[(3)]	**>80%**	**>85%**	**≥90%**
Plant Capital Cost[(2)] **$/kW**	**1000 – 1300**	**900 – 1000**	**800 – 900**
Cost of Electricity[(4)] **¢/kWh**	**3.5**	**3.0 - 3.2**	**<3.0**

(1) Targets are w/o carbon capture and sequestration and reflect current cooling tower technology for water use

(2) Range reflects performance projected for different plant technologies that will achieve environmental performance and energy cost targets

(3) Percent of time capable of generating power (ref. North American Electric Reliability Council)

(4) Bus-bar cost-of-electricity in today's dollars; Reference plant based on $1000/kW capital cost, $1.20/$10^6$ Btu coal cost

Clean Coal Power Initiative (CCPI)

- **Drivers**
  - Clear Skies Initiative
  - Reduced carbon intensity
  - Zero emissions technology goals
  - Energy/economic security

Round 1 (Broad)
- Advanced coal-based power generation
- Efficiency, environmental & economic improvements

Round 2 (next up)

- **Technology Demonstration Opportunities**
  - 3P control systems (SO_2, NOx and Mercury)
  - High-efficiency electric power generation
    - Gasification
    - Advanced combustion
    - Fuel Cells and Turbines
  - Retrofit, Repowering and new Merchant Plants

Clean Coal Power Initiative
Technical, Economic & Market Barriers/Hurdles

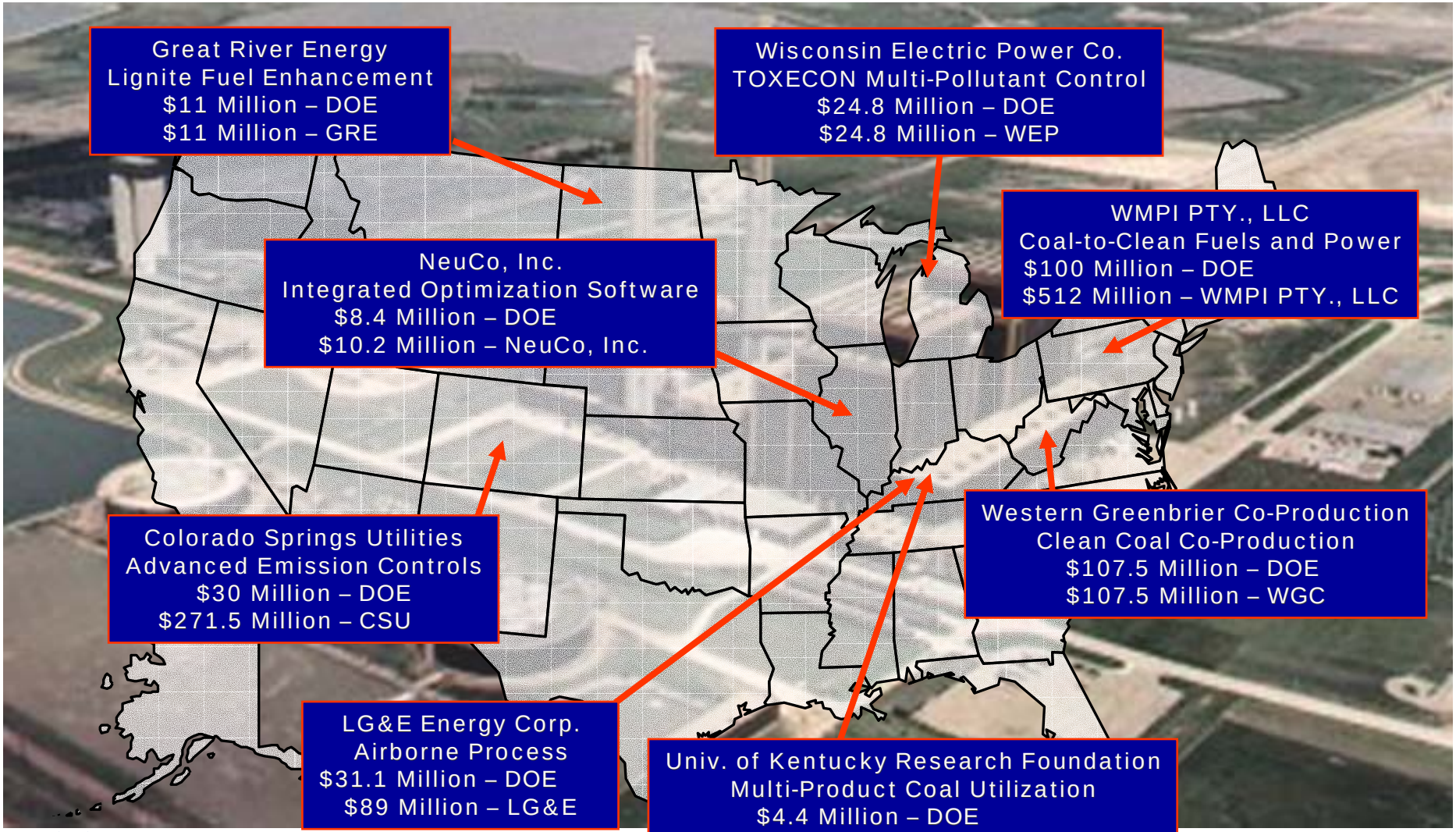
- Securing minimum 50% private sector cost-sharing for demonstrating first-of-a-kind technologies (high risk)
  - On high-interest technologies needed to meet coal program performance goals
- Repayment obligations dampen commercialization goals
- Achieving a fair balance of federal/private sector interest in intellectual property
- Uncertain mid- and long-range market conditions (e.g. energy prices, environmental regulations, global climate change policies)
- Deregulation inhibits risk-taking -- drives industry away from R&D and higher-risk investments

CCPI Round 1 Project Selection — *Activity Summary Status*

- **Project selections announced**
  - Selection announcement Techline issued
  - Project descriptions posted on CCPI website www.netl.doe.gov/coalpower/ccpi

- **Pre-Award activities in progress**
  - Fact-finding, NEPA review, and benefits and repayment analysis underway
  - Pre-Award meeting held with participants in Pittsburgh on February 5, 2003 (70+ attendees), all 8 projects represented

Clean Coal Power Initiative (CCPI) – Round 1



Preliminary NEPA Evaluation Results

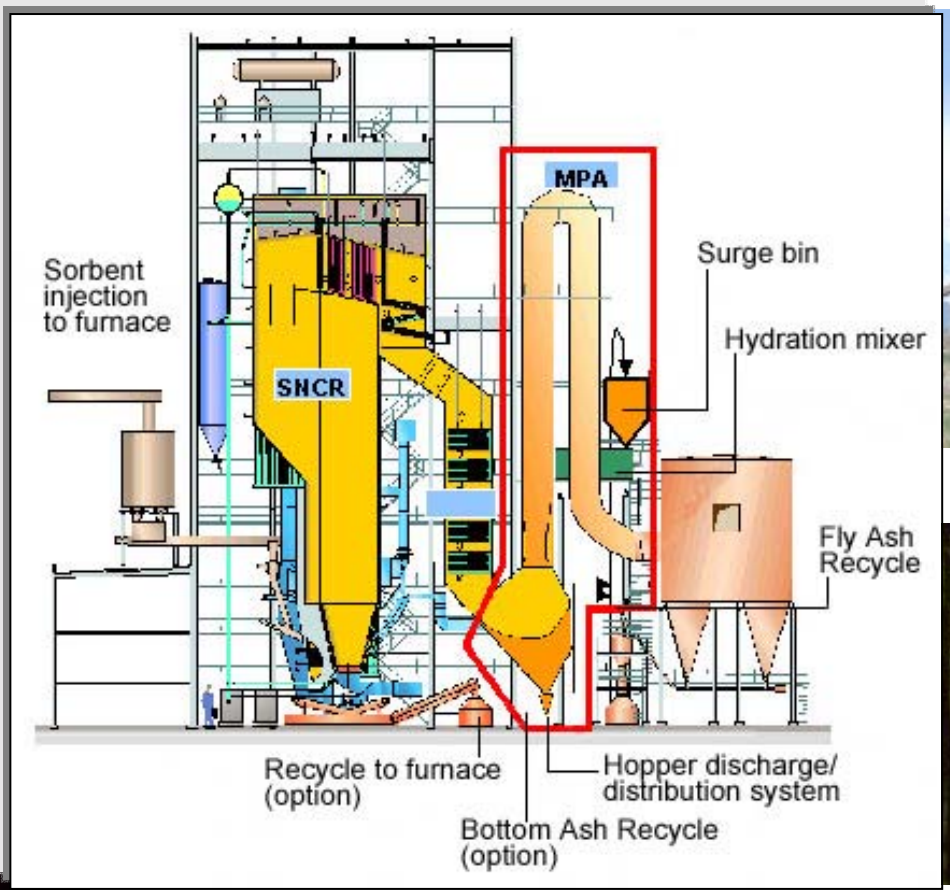
- **Probable Environmental Impact Statements (EIS)**
  - City of Colorado Springs
  - Waste Management & Processing, Inc.
  - Western Greenbrier Co-Gen LLC
- **Probable Environmental Assessments (EA)**
  - Great River Energy
  - Louisville Gas & Electric Corporation
  - University of Kentucky Research Foundation
  - Wisconsin Electric Power Company
- **Probable Categorical Exclusion**
  - NeuCo, Inc.

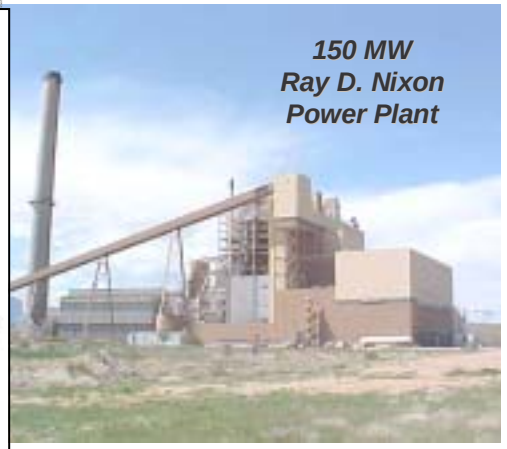
CCPI Round 1

2 New CFBs

Colorado Springs Utilities

- One of cleanest coal-fired power plants for SOx, NOx and Mercury Control in U.S.
- Uses variety of fuels: bituminous, subbituminous, coal wastes, and wood wastes





A CCPI Round 1 Project

Background

- Colorado Springs Utilities (CSU) and Foster Wheeler are teaming to demonstrate an 150 MW commercial-scale, advanced, low-cost, emission control system
- Location: the Ray D. Nixon Power Plant south of Colorado Springs, CO
- Fully integrated emission controls for SOx, NOx, mercury and other trace metals will be combined with CFB combustion
- Project goal is to demonstrate all of these systems in a single unit at a commercial-scale

Technology Uniqueness

- NOx control system features an advanced staged-combustion system coupled with SNCR, achieving emissions reductions comparable to higher-cost SCR controls
- SOx control design features a three-stage approach to achieve highest capture with lowest limestone consumption (half that of conventional systems)
- A low-cost, integrated, trace metal control system can remove up to 90% of Hg, Pb, and other metals and virtually all acid gases
- Solids separator system, integrated into furnace structure, improves reliability and lowers cost and:
  - Allows reduced combustor size
  - Eliminates hot expansion joints
  - Improves operational performance
  - Reduces maintenance costs
- A dry cooling tower is used to minimize water use

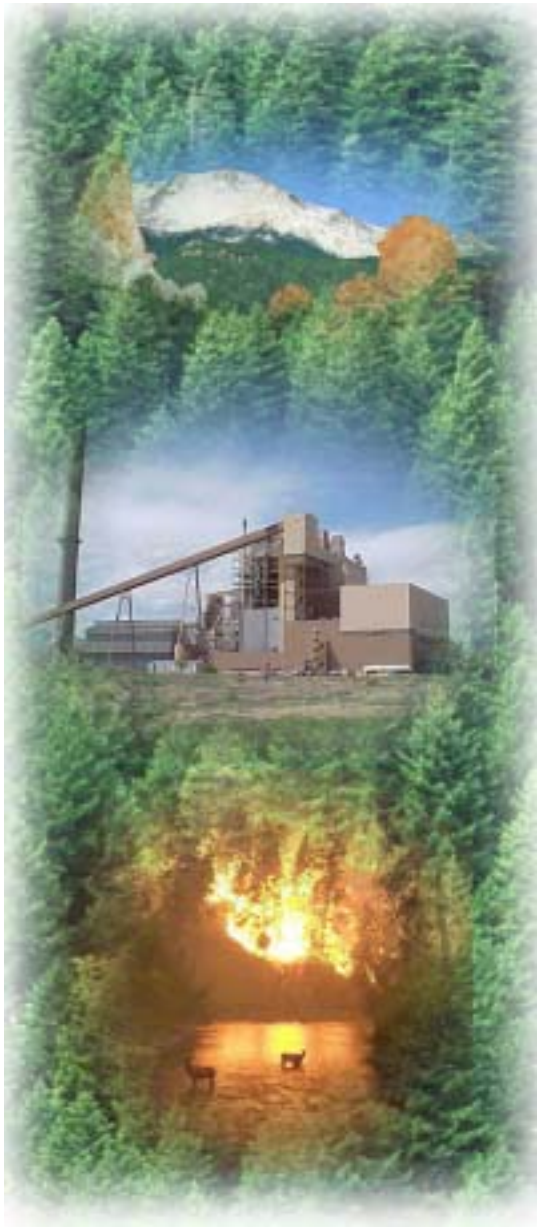
All pollution control systems are integrated into a single Commercial-scale Unit

Schedule

- **NEPA Process – Completing Environmental Impact Statement**
  - April 10, 2003 to June 6, 2005
- **Design**
  - September 15, 2003 to May 1, 2006
- **Construction**
  - June 6, 2005 to March 2008
- **Operations – Proving the Technology**
  - March 2008 to July 2009

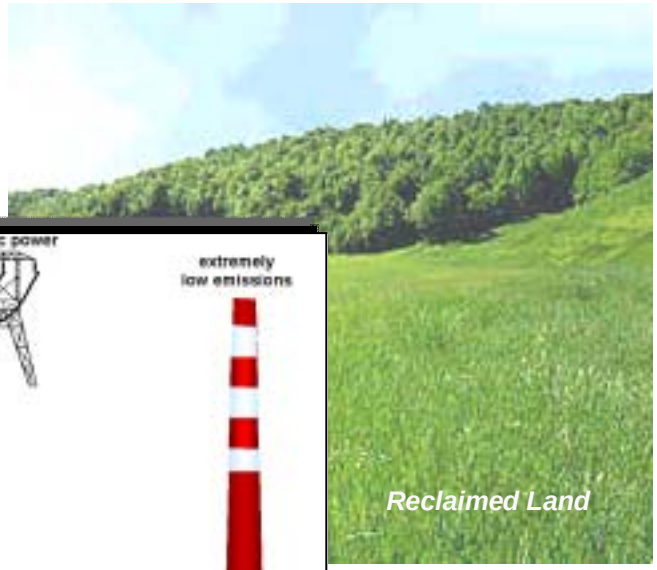
Potential Benefits

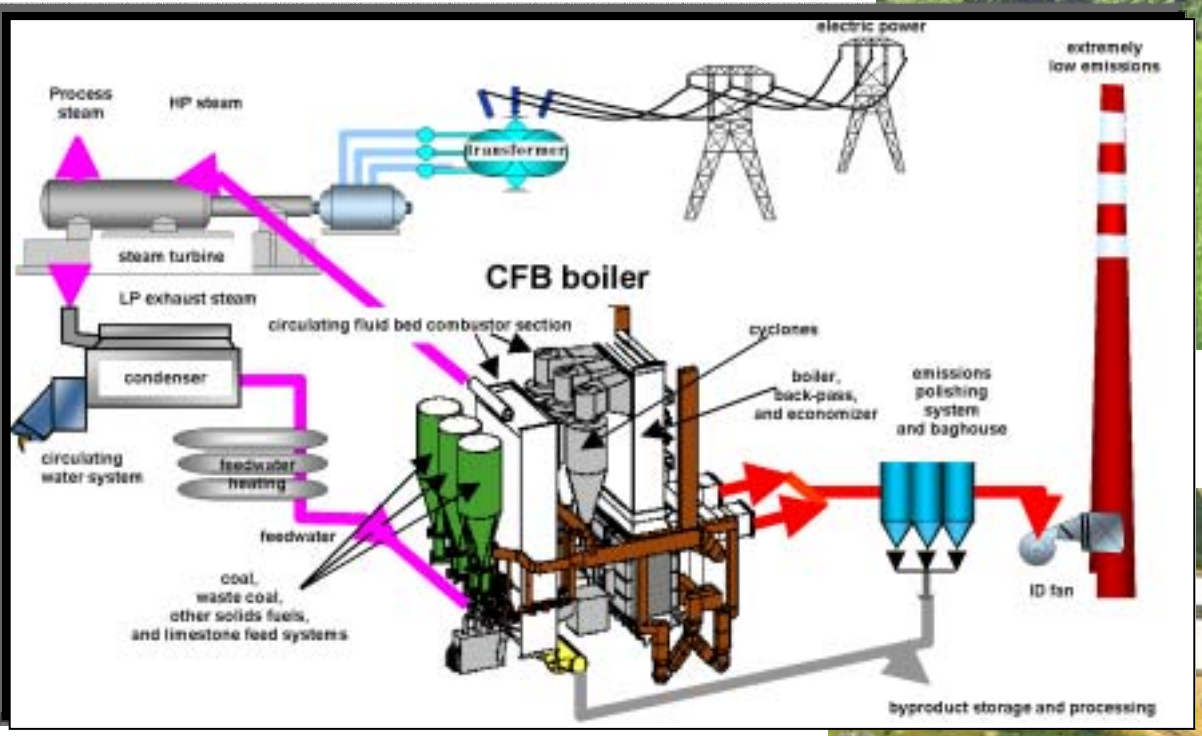
- This project will demonstrate a low-cost emission control system for CFBs predicted to achieve:
  - Low levels NOx emissions (0.04 lb/Million Btu with PRB coal)
  - Very high sulfur control (96-98% removal)
  - Up to 90% emissions control of Hg and other trace metals
- This demonstration will use a variety of fuels to make electricity including:
  - Bituminous and subbituminous coals
  - Steel industry coal waste, an environmental legacy
  - Wood waste removed from forests for wildfire management

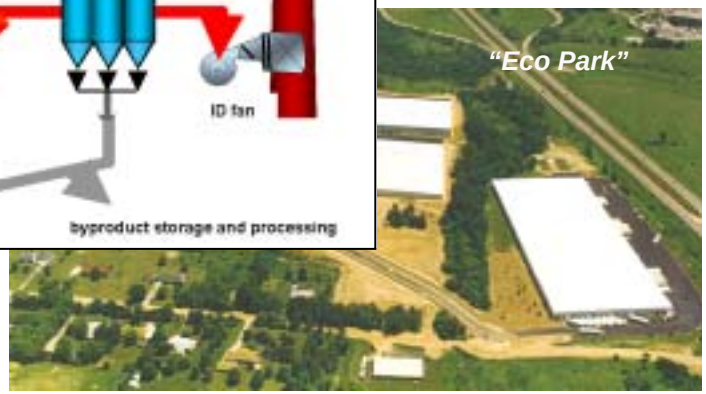


Western Greenbriar Co-Generation, LLC

- Anchor tenant in a proposed environmentally balanced industrial “Eco Park”
- Remediation model for State/Local Governments
- 85 MW waste-coal to energy Fluid Bed Combustor







A CCPI Round 1 Project

Background

- A new public service entity serving three municipalities (Rainelle, Rupert, and Quinwood) in Greenbriar County, WV
  - WGC will demonstrate an innovative 85 MW CFB system incorporating state-of-the-art multi-pollutant controls
- Team members include:
  - Parsons E&C (Reading, PA), turn-key systems contractor for municipalities teaming with Alstom Power Inc. (Windsor, CT) to provide CFB technology
  - Midway Environmental Associates (Arvada, CO) and Hazen Research (Golden, CO) will use boiler ash and green wood waste to produce 300 tpd structural bricks
- Fuel:
  - Waste coal (1,610 TPD) from a four million ton refuse site in Anjean, WV and 220 TPD freshly mined coal

Technology Uniqueness

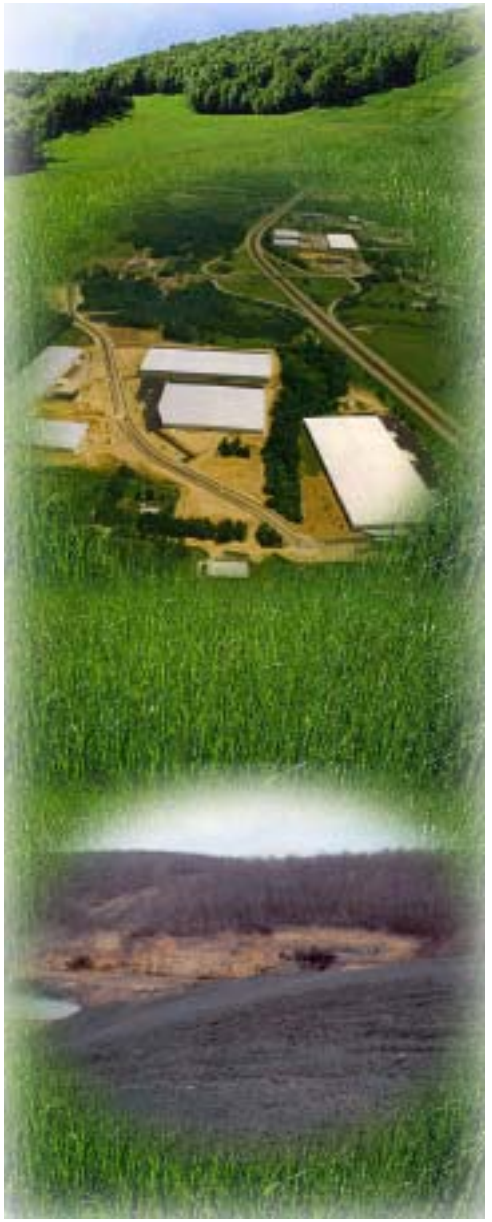
- This advanced, compact power plant design:
  - Employs state-of-the-art multi-pollutant controls (SOx, NOx, particulate, and mercury)
  - An inverted cyclone design enables boiler components to be rearranged with a more compact configuration reducing standard “footprint” by 40%
    - Reduces structural steel and related construction costs by 60%
    - Shortens construction time and increases safety
- Hot water from turbine exhaust will be used by “Eco Park” to provide district heating and steam for potential industrial uses such as drying hardwood in a steam kiln
- An integrated co-production facility produces value-added structural bricks
- Maximum generating efficiency, reduced CO_2 emissions, water conservation, and co-production of steam is achieved by plant’s innovative design

Schedule

- **NEPA Process – Completing Environmental Impact Statement**
  - March 25, 2003 to November 15, 2004
- **Design**
  - December 1, 2003 to July 30, 2005
- **Construction**
  - December 1, 2004 to March 15, 2007
- **Operations – Proving the Technology**
  - September 1, 2007 to January 1, 2009

Potential Benefits

- Improved industrial ecology from employing advanced multi-pollutant control systems
- Coal waste “Gob Pile” remediation (West Virginia alone contains approximately 400 million tons of Gob)
- Successful integration of these technologies and development of this facility can serve as a model for Gob remediation in United States and abroad
- Acid mine drainage remediation (using alkaline ash)
- Hi-quality, long term employment at plant and Eco Park
- Beneficial use of coal ash by-products



Business Management Experiences with CCPI Round 1 Applications

CCPI Round 1
Business Management Perspectives

- **Solicitation was clear in its specific information requests;**
  - host sites, marketing plans, financial capability, repayment plans and descriptions, budget information…
- **Requirements were consistent with financial norms;**
  - Banks, capital markets funds providers and other federal agencies

CCPI Round 1
Business Management Issues

- **Some applications included straightforward commitment letters -- However,**
  - Some were vague and heavily conditioned
  - Some were unclear as to which corporate entity actually planned to provide project funding

- It is important for funding commitments to be both **specific** and **definite**
  - Particularly with respect to funding for Project Definition Phase (if proposed)
  - Minimum funding conditions should be set out

CCPI Round 1
Business Management Issues

- **Responses related to applicant's willingness to cover cost increases covered wide a range**
  - no response at all -- to broad statement that any and all cost increases would be covered

- Serious project developers arranged a combination of reserves and other types of support to cover at least a portion of cost increases
- Commitment letters should describe how cost increases will be covered, in what amounts, and by whom

CCPI Round 1
Business Management Issues

- **In some applications, Sources of Funds and Uses of Funds were difficult to reconcile, particularly during Project Definition phase**

  - Application should include a Sources and Application of Funds statement--describe how funds from specific sources will be used

CCPI Round 1
Business Management Issues

- **Host site could not be evaluated in some applications because site documentation was inadequate**
  - A site, or alternate sites, were not identified
  - No evidence provided that proposed site was available to project
  - No discussion of appropriateness of site for planned demonstration

- If applicant is not site owner, a legally binding fully definitized Host Site Agreement must be in place prior to award (can be time-consuming)

CCPI Round 1
Business Management Issues

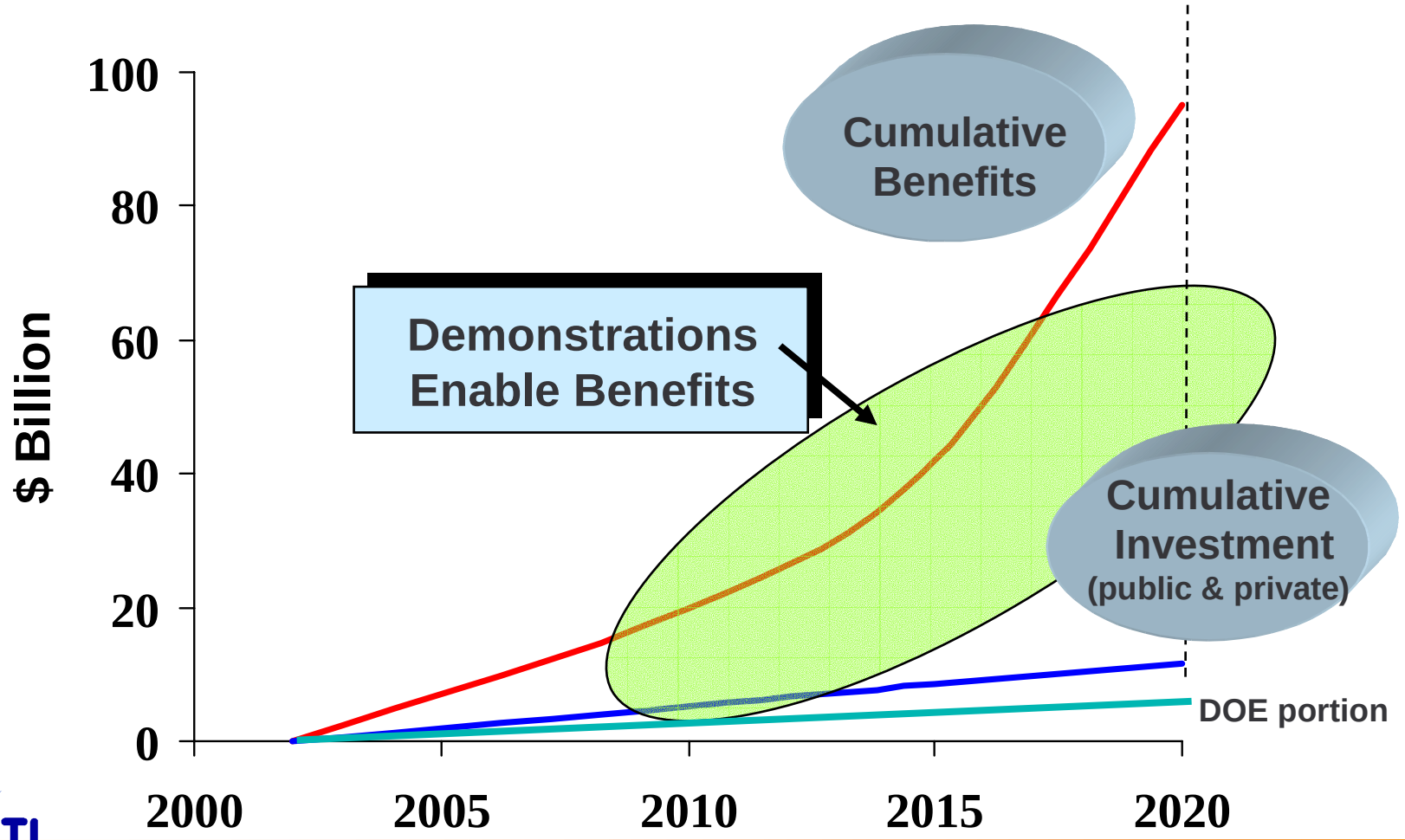
- **Some Repayment Plans lacked credibility, because of superficial economic and business analysis**
- **Full repayment of DOE cost share appeared speculative in some responses**
  - Repayment was point-scored in evaluation
- **Commercialization planning was incomplete or unrealistic in some cases**

- In a competitive solicitation applicants cannot afford to give points away

On To Program Benefits!

Demonstration Initiatives are Key Pathway to Benefits

Coal Program - Benefits/Investment



Coal Power Program (RD&D) – Economic Benefits

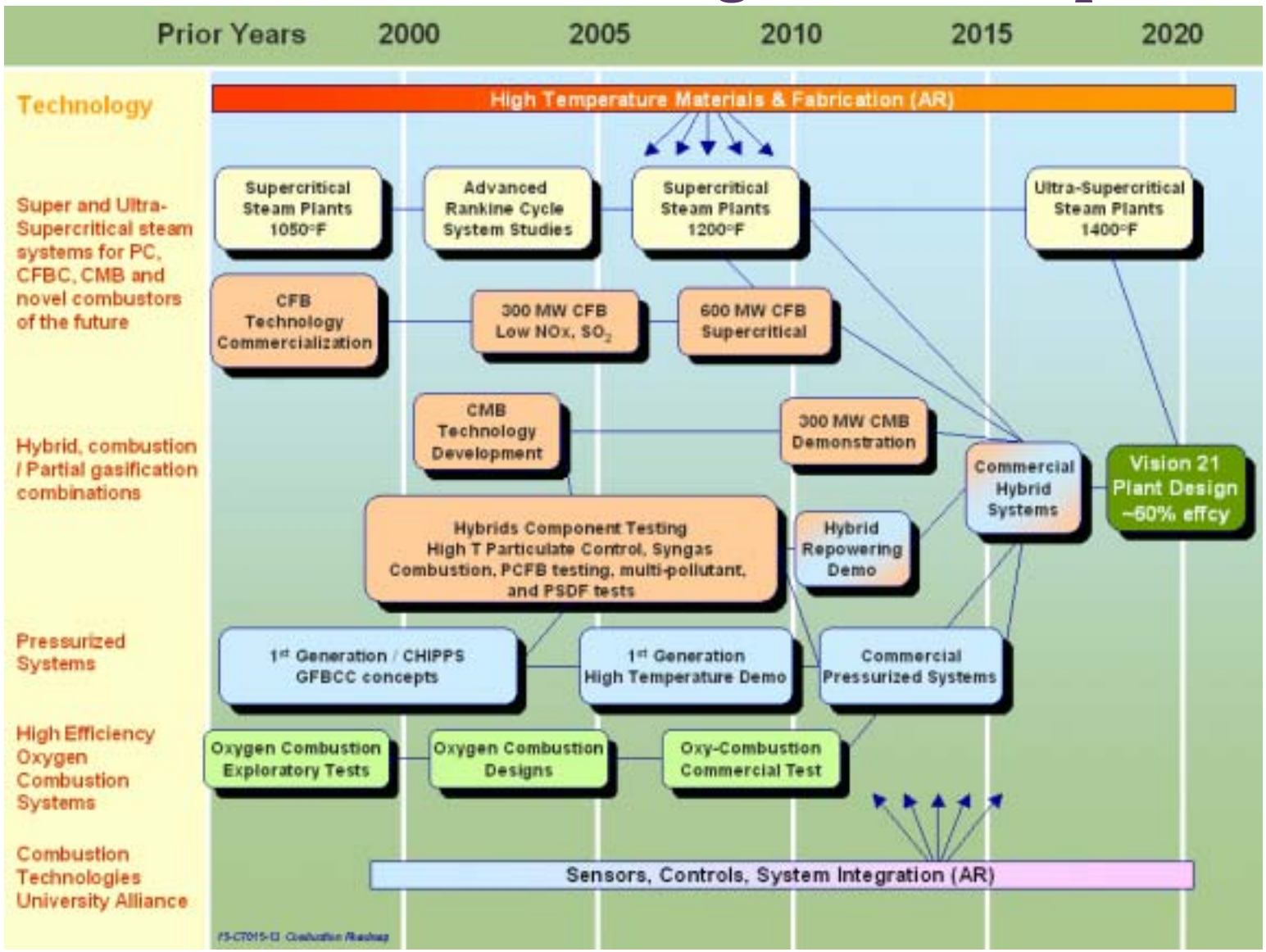
Savings Categories	Cumulative Benefits ($ billions, thru 2020)
Fuel Cost	10
Capital Cost (New Plants)	12
Control Technology Cost (Existing Plants)	32
Avoided Environmental Costs	10
Technology Export	36
Total Benefit	**100**

Other Benefits

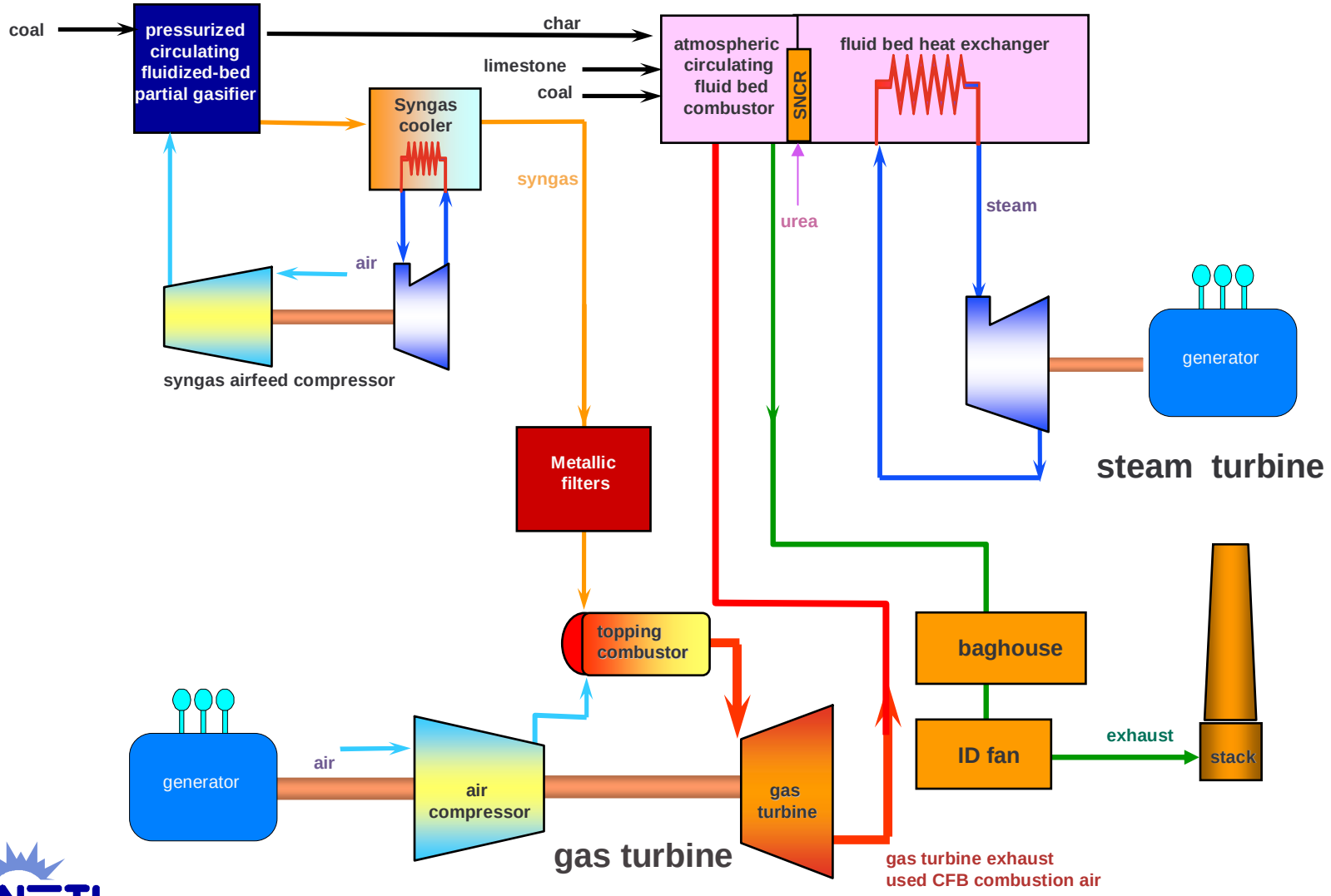
- Increased jobs from technology export – estimate 75,000 new jobs in 2010 increasing to 200,000 in 2020
- Additional $500 billion to $1 trillion savings through 2050 if loss of coal option results in 1-2 ¢/kWh increase in cost of electricity

Can Fluid Bed Combustion Technology play in future CCPI Rounds?

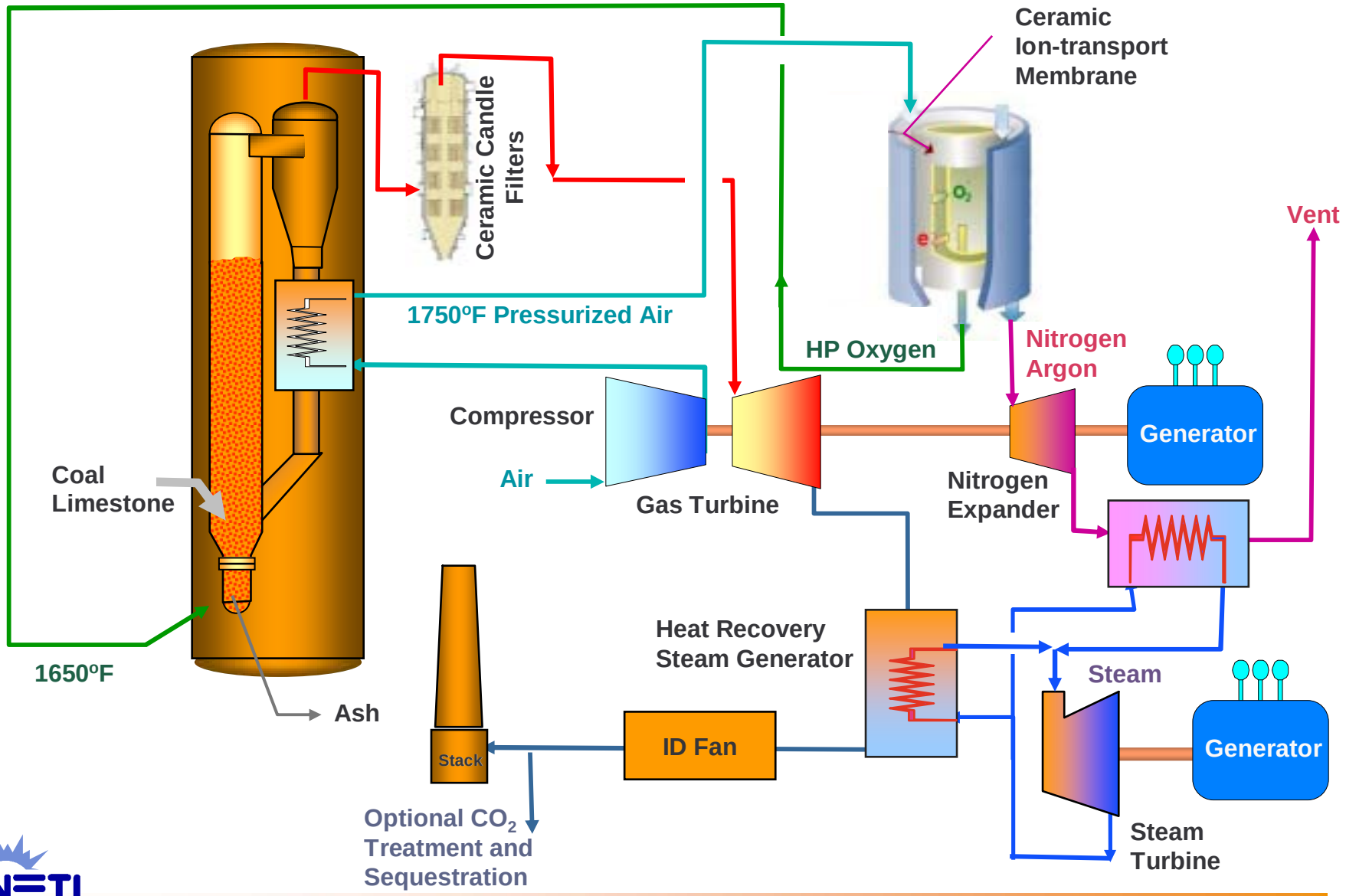
Combustion Technologies Roadmap



HYBRID: Gasification Fluidized Bed Combustion Combined Cycle (GFBCC)



Oxygen-Fired PCFB



Trend in Ultra-Supercritical Technology

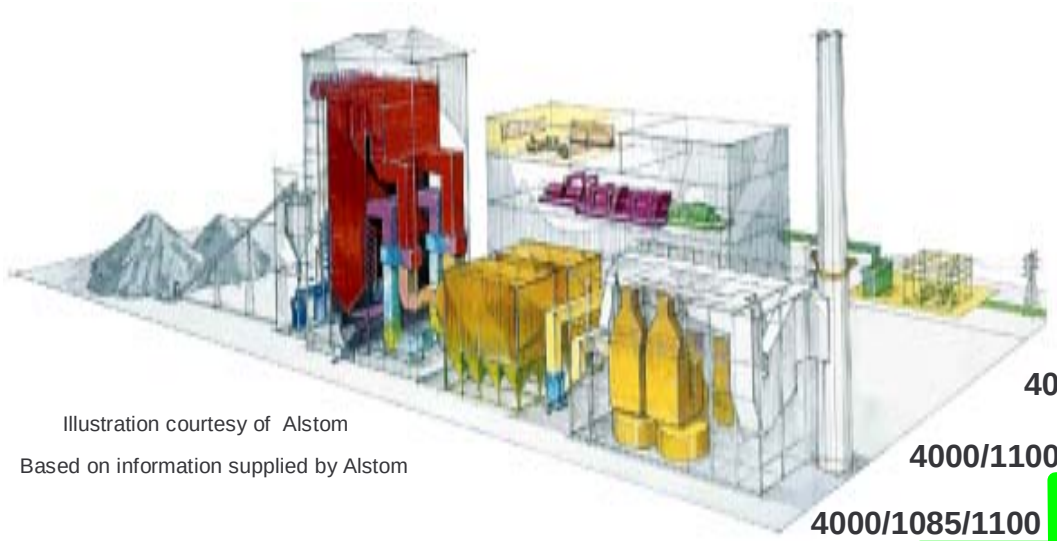


Illustration courtesy of Alstom

Based on information supplied by Alstom

US USC Goal

Improvement in Energy Efficiency

2400/1005/1005

3480 psi / 1005ºF / 1050ºF

3600/1050/1085

4000/1085/1100

4000/1100/1150

4000/1165/1200

5400/1300/1325/1325

Mature technology

Current Market introduction

Market introduction by Japan R&D ongoing (COST) in Europe

R&D ongoing Thermie project (Ni-base)

1950's 1960's 1970's 1980's 1990's 2000's 2010's

Cost-Effective Materials Are Key

Coming CCPI Solicitation Planning Opportunities

- 28th International Technical Conference on Coal Utilization and Fuel Systems, Clearwater, Florida, March 10-13, 2003-(complete)
- Pittsburgh Coal Conference, Pittsburgh, PA, September 15-19, 2003
- Clean Coal and Power Conference, Ronald Regan Building, Washington, D.C., November 17-19, 2003

Monitor www.fe.doe.gov or www.netl.doe.gov/coalpower/ccpi websites for coming events

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www.netl.doe.gov

Visit Our OCES Website

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www.netl.doe.gov/coalpower/ccpi